



COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

HENRY WARD
COMMISSIONER OF HIGHWAYS

November 18, 1964

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

MEMORANDUM

H. 1.65.42

TO: W. B. Drake
Assistant State Highway Engineer
Chairman, Kentucky Highway Research Committee

SUBJECT: Research Report; Experimental Feature, Construction
Project F 160(10), U.S. 127, Mercer County, KYHPR-
65-42*; Part II, HPS-HPR-1(26); EXPERIMENTAL
GUARDRAIL INSTALLATIONS AND PERFORMANCE
STUDIES.

The report submitted herewith pertains to an experimental installation of aluminum guardrails which was completed in February, 1963. Progress reports, as required by PPM's 60-2 and 50-1.1, have been pending since the project began; however, all of the eligible information has been combined into the current report. Of course, long-time performance histories cannot yet be documented; and, for that reason, the report is considered to be interim rather than final.

The full significance of experimental features in construction projects, such as this one, or of other performance investigations may not be readily apparent from the texts of the reports issued - this is especially true of stereotyped, interim reports which merely document the histories and facts for future analysis. In some respects at least, this describes the nature of our present report; however, there are some relevant insights - as I have already implied - which might be explained more appropriately here than in the report.

It is incumbent upon the Department as well as the Bureau of Public Roads to determine the minimum level of qualities or characteristics which will qualify construction materials (including so-called highway hardware) for each type of service or application, practiced or envisioned, in the design, construction, and maintenance of highways. Further, the competitive spirit of business and industry is to be respected, honored, and perpetuated - implying that the opportunity-to-bid cannot be denied on

the basis of type or kind of material or product - provided, of course, that each type or kind has been determined to be of satisfactory quality and found to be acceptable on the basis of an engineering analysis. Hence, the principle of competitive bidding embraces all qualifying, so-called, equal alternates.

Our experimental installation of aluminum guardrail elements was authorized by the Bureau on July 31, 1961; previously, however, the Department had been specifying aluminum for bridge rails, lamp posts, signs, and sign supports. Two sections of corrugated, aluminum, culvert pipe were placed in test September 13, 1961, at Mortons Gap (corrosion test). Under the date of October 9, 1962, the Bureau issued I. M. 40-2-62 and C. M. 32-30 on the subject of the "Use of Aluminum in Competition with Alternate Materials in Federal-aid Highway Construction"; I. M. 40-2-62 was superseded by I. M. 40-3-62, December 21, 1962, which pertained generally to procedures for selecting products and taking bids; this was followed by C. M. 30-3, December 18, 1963. I have appended copies of the aforementioned documents for convenience of reference. It is my understanding that I. M. 40-3-62 is now the principal guide in these matters.

Presumably, the principle of specifying alternates is not limited solely to first-cost considerations; for instances, in comparisons between two materials, one may be found to offer a low first-cost but involve high maintenance costs; whereas, the other may have a high first-cost and a low maintenance cost. Ideally, equality of alternates should be adjudged on the basis of long-range costs. Weighting factors might be used to equate any disproportionalities in over-all costs; however, in the absence of performance records to adequately substantiate proportionalities, it is understood that the first-cost basis will govern.

Experimental construction is recognized as a procedure for obtaining performance and cost records when they cannot be obtained from standard construction practices. Of course, performance and cost studies and re-valuations may be made in situations where equal alternates have been specified in standard practice; and weighting factors may be so established and applied to all future work.

It is not necessary for a state to rely solely upon its own experience records to substantiate equality or proportionality - rather, authoritative engineering and research reports may suffice in lieu of a state's own records. In any case, the claims made must be satisfactorily substantiated.

W. B. Drake

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November 18, 1964

Our experimental project has demonstrated that aluminum guardrail elements can be fabricated and erected satisfactorily; performance thus far has been favorable; however, the initial cost of the aluminum was higher than the cost of galvanized steel and painted steel rails. Other construction projects will supply supporting performance comparisons between galvanized steel and painted steel. We do not have any painted, galvanized steel in service at this time.

Contractors have demonstrated a distinct preference for galvanized steel rails in instances where alternates have been specified or permitted. This is attributed to the fact that field painting of steel rails is a bothersome chore. There is a possibility that contractors might favor aluminum because of its weight and handling advantages.

We will continue our observations on the Mercer County project and will continue to compile cost and maintenance data from other projects. Suggestions and comments are invited.

Respectfully submitted,



James H. Havens
Director of Research
Secretary, Kentucky Highway
Research Committee

Attachments

cc: Research Committee

R. O. Beauchamp
R. L. Campbell
T. J. Hopgood
A. O. Neiser

Director, Division of Construction
Director, Division of Materials
Engineer of Specifications

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
WASHINGTON 25, D.C.

October 9, 1962

CIRCULAR MEMORANDUM TO: Regional and Division Engineers

FROM: G. M. Williams, Director of Engineering *GMW.*
32-30

SUBJECT: IM 40-2-62 dated October 9, 1962
(Use of Aluminum in Competition with Alternate
Materials in Federal-aid Highway Construction)

Questions have arisen frequently in recent months relative to the use of aluminum products in Federal-aid highway construction in preference to or as an alternate for products composed of other materials. Representatives of the aluminum industry have contended that in some States aluminum products are in effect excluded from use because of selections being made solely on the basis of relative initial costs of the materials. Other States, however, have apparently in some cases been specifying aluminum exclusively regardless of higher initial cost. Still other States have been requesting or requiring alternate bids. In order that Federal-aid participation may be applied on a uniform basis nationwide, the policy set forth in the enclosed IM 40-2-62 dated October 9, 1962, is to be followed on all Federal-aid projects that have not been advertised for bids by the effective date of the instructional memorandum.

Experience has indicated that in most, but not all, cases aluminum products are unable to compete successfully with alternate products on the basis of initial costs only. It is argued, however, by the advocates for use of aluminum that when estimated annual costs are considered the ultimate cost to the public will be less for aluminum products than for alternates. It has not yet been conclusively established that such is the case. Even though it were to be accepted that ultimate costs would be lower, this factor alone is not considered to constitute justification for Federal participation in higher initial costs. The procedure prescribed in IM 40-2-62 will permit the public to gain the benefit of savings in ultimate costs whenever the States elect to absorb the difference in higher initial costs for aluminum products.

It is recognized that the relative merits of aluminum products and alternates have not yet been firmly established. In addition to initial and ultimate costs and engineering considerations, there may be other factors, such as safety, esthetics, and salvage values, that should be used. Some type of formula could perhaps be developed that would give appropriate weight to each pertinent factor and such a formula, if its reliability and firmness are adequately demonstrated, might then be used as a basis for selection of alternates. It may also be possible to develop a better basis for determining the extent of Federal participation than the one prescribed in IM 40-2-62. It is suggested that your offices and the State highway departments explore these possibilities and let us have your ideas and recommendations for consideration. In the meantime, however, the policy and procedures prescribed in IM 40-2-62 are to be applied.

Enclosure (See Reverse Side)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
WASHINGTON 25, D.C.

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U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
WASHINGTON 25, D.C.

October 9, 1962

INSTRUCTIONAL MEMORANDUM 40-2-62
32-30

SUBJECT: Use of Aluminum in Competition with Alternate Materials
in Federal-Aid Highway Construction

The use of aluminum in preference to or as an alternate for steel, wood and other materials in sign panels, lighting and sign supports, guard rails, bridge railings, fencing, culvert pipe, and other highway construction components is frequently being specified or proposed for Federal-aid projects.

Whenever the use of such construction components composed of aluminum is specified and Federal participation therein is desired, provision is to be made for alternate bids on a competitive basis for the use of at least one other suitable material. In order that relative unit prices for alternates may be ascertained and in order that the State may select the alternate it desires, each contractor should be required to bid on each alternate. If the State makes its award on the basis of the lowest priced alternate in the lowest overall bid on the entire project, there may be Federal participation in the full final contract amount for the item. If for some reason other than as provided in the exception stated below, the State elects to make its award on the basis of a higher priced alternate in the lowest overall bid, the division engineer may concur in such award, but with Federal-aid participation limited to the Federal share of the amount that would have been involved had the State made award on the basis of the lowest priced alternate.

Exceptions may be made to the above prescribed policy when the use of aluminum to the exclusion of alternate materials can be justified on the basis of engineering considerations other than relative costs of the materials. Examples would be when reduction in weight is an overriding factor in structural design and when unique chemical conditions make the use of aluminum advisable. Reduced maintenance costs will not be sufficient basis for an exception.

To permit bidding competition between products made of aluminum and of alternate materials in cases not covered by the stated exception, the designs for the alternates should be as similar functionally as it is reasonably possible for the materials to be used, shall be based on the same specifications for capacity and load conditions, and there shall be specifications for physical properties of the materials to be bid as alternates.



G. M. Williams
Director of Engineering

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
Washington, D. C. 20235

December 18, 1963

CIRCULAR MEMORANDUM TO: Regional and Division Engineers

FROM: F. C. Turner, Assistant Federal Highway Administrator
30-03 and Chief Engineer

SUBJ: IM 40-3-62 dated December 21, 1962

C
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P
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We continue to receive in the Washington office complaints that there are differences in the application or interpretation of the policies contained in our several previous memoranda concerning the procedures for handling the governing specifications, invitations for bidding, and amounts of Federal participation to be allowed in situations where the final selection of an acceptable material or product to be incorporated into a Federal-aid project involves competitive types of products.

Public Roads' policy on this subject is of long standing, developed many years ago, reviewed in Congressional hearings, and stated many times in Congressional and other official correspondence, project approvals, and in published regulations and public statements. It is designed to provide the public with fully acceptable highway service at the minimum cost while utilizing the traditional free enterprise and competitive bidding processes. There are adequate procedures also of long standing which outline Federal participation in experimentation needed to constantly seek out and develop new and improved materials and products, but these are not a subject for consideration in this discussion.

In general terms, the Public Roads policy on selection between optional competing materials and products is restated below:

- (1) Competing materials and products will be evaluated from the results of research, performance records, or other pertinent experience so as to establish their acceptability to meet governing project requirements.
- (2) When this evaluation clearly shows that one particular material or product is consistently less costly or is qualitatively superior to all others in a degree sufficient to justify its selection after considering any added cost for the superior service to be rendered, it may be specified

for use and Federal funds may participate in the normal manner in the costs resulting from its use. Such evaluations are to be made by using normally accepted engineering and economic judgements, together with any other factors determined to be pertinent. The evaluation is to be made a part of the State Highway Department project submission to Public Roads, and the State's finding must be concurred in by Public Roads. Where possible to do so, the results of the evaluation process, once made and concurred in, may be incorporated into the individual project papers merely by reference in order to simplify project procedures.

- (3) When through this evaluation process, however, two or more of the competing materials or products are deemed to be reasonably comparable in quality, service, cost, and other pertinent factors, they shall be included in the project specifications (either the Standard Specifications or Special Provisions) as optional items, and the choice of one is to be made at the election of the contractor whose bid is accepted. The State may determine the unit price to be paid to the contractor for the optional material or product selected by him in one of the following ways:
- (a) by the unit price as bid by the contractor for the subject item and quantity; or
 - (b) by listing in the bid schedule each of the optional materials and products permitted by the Specifications or Special Provisions and letting the contractor enter on the bid schedule a price on one or all of them; or
 - (c) some other method mutually acceptable to both the State and Public Roads which accomplishes the same objective.

In any of these methods, the award will be based on the overall lowest responsive bid for the entire contract determined in the usual manner.

- (4) Public Roads has no preference as to which of the above methods is used.
- (5) Where a State desires to specify a single material or product without obtaining Public Roads' concurrence as set out in (2) above, the item will normally be nonparticipating; however, a State may still select a single option of their choosing without Public Roads' concurrence in that selection and still receive participation if the bidding procedure described in (3)(b) above establishes unit prices on each of the optional alternates, in which case Federal-aid participation will be based on the lowest price so established.

These general statements of principle are intended to be applicable to any and all competing materials and products used in Federal-aid projects such as, but not limited to, base and subbase aggregates and admixtures, culvert pipes, pavement striping, guard rails, fencing, sign backing and supports, light poles, joint materials, curing compounds, etc., etc. It is not intended that items mentioned above that are normally subsidiary and not bid as separate items shall be changed from the practice followed at this time; but, similar principles are to be followed in order to insure that the most acceptable work at the lowest cost to the public shall be obtained whether such items are set out separately in the bidding schedule or included as subsidiary to some other bid item.

While the same overall objective of maximum service at lowest cost to the public applies equally to numerous other items of work such as pavement and bridge types, this particular memorandum is not to be construed as extendable to these questions. They are or will be covered in other memoranda.

Any Regional or Division office instructions not in accord herewith are to be withdrawn or modified on receipt of this memorandum. This memorandum does not cancel or supersede any previous Washington office memorandum on this subject, but is merely a further effort to restate, reiterate and clarify, and to obtain more uniform application of the previous issuances on this subject. It would be well to refer back to the basic IM 40-3-62 on this subject. Division Engineers are to allow a reasonably adequate time for the State to develop and adjust procedures if necessary to carry out this restatement of intent. No current PS&E papers that are otherwise acceptable are to be delayed for revision based on this memorandum. It is expected that necessary adjustments, if any are required, will be made promptly with regard to PS&E now being prepared.

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
Washington 25, D. C.

December 21, 1962

INSTRUCTIONAL MEMORANDUM 40-3-62
32-01

SUBJECT: Federal-aid Highway Construction Projects, Product
Selection and Bidding Procedures

This memorandum supersedes Instructional Memorandum 40-2-62 dated October 9, 1962, and will be applicable to all plans, specifications, and estimates approved on and after Feb. 18, 1963.

C When there is available for purchase more than one nonpatented,
nonproprietary material, semifinished or finished article or
O product that will fulfill the requirements for an item of work
of a project and these available materials or products are
P judged to be of satisfactory quality and equally acceptable on
basis of engineering analysis and the anticipated prices for
the related item(s) of work are estimated to be approximately
Y the same, the P.S. and E. for the project shall either contain
or include by reference the specifications for each such material
or product that is considered acceptable for incorporation in
the work. Bidders will submit a price for the item of work and
the successful bidder for the project shall inform the contract-
ing agency either at the time of or prior to the execution of
the contract of the material or product that will be furnished.
In the event the contracting agency wishes to substitute some
other acceptable material or product for the material or pro-
duct designated by the successful bidder, and such substitution
results in an increase in costs, there will not be Federal-aid
participation in any increase in costs.

If a contracting agency desires to specify some one material or
product when there are other acceptable materials and products,
this procedure may be approved with the usual Federal-aid
participation when such single choice is recommended by the
contracting agency and accepted by Public Roads as being in the
public interest. When this recommendation cannot be justified
by the contracting agency to Public Roads' satisfaction, it
will be necessary to use the procedure of providing specifications
for the acceptable materials and products and of bidding as
described in the second paragraph.

Signed _____

F. C. Turner

Assistant Federal Highway Administrator and Chief Engineer

Preconstruction, Construction, and Interim Performance Report

on

EXPERIMENTAL GUARDRAIL INSTALLATION
AND PERFORMANCE STUDIES

KYHPR-65-42*; HPS-HPR-1(26)
(F 160(10), Mercer Co., U.S. 127)

Report No. 1

by

Jas. H. Havens, Director of Research

and

D. C. Cowherd, Research Engineer

DIVISION OF RESEARCH
Kentucky Department of Highways

in cooperation with the
BUREAU OF PUBLIC ROADS
U.S. Department of Commerce

November 1964

I. Project Numbers, Termini, Station Numbers, and Distances

F. 160(10), MERCER COUNTY, U.S. 127
Harrodsburg-Lawrenceburg Road, Sta. 431+60 to Sta. 650+50

Painted Steel Guardrail:
Northbound Lanes

Station 500+00	to	502+50	250.0 l.f.
513+50	to	519+12.5	562.5 l.f.
519+875	to	521+25	137.5 l.f.
551+25	to	553+12.5	187.5 l.f.
571+25	to	577+50	625.0 l.f.
597+87.5	to	603+87.5	600.0 l.f.
613+75	to	616+00	225.0 l.f.
624+75	to	626+62.5	187.5 l.f.
Total			2775.0 l.f.

Galvanized Steel Guardrail:
Northbound Lanes

Station 627+25	to	632+50	525.0 l.f.
651+62.5	to	652+12.5	50.0 l.f.

Southbound Lanes

Station 534+50	to	539+75	525.0 l.f.
552+62.5	to	553+62.5	100.0 l.f.
567+37.5	to	575+12.5	775.0 l.f.
598+50	to	604+00	550.0 l.f.
651+87.5	to	652+50	62.5 l.f.
Total			2587.5 l.f.

Aluminum Guardrail:
Southbound Lanes

Station 432+50	Radius	(Curved Sections)	75.0 l.f.
432+50	Approach		25.0 l.f.
432+50	to	434+25	175.0 l.f.
449+00	to	450+50	150.0 l.f.
458+45	to	459+20	75.0 l.f.
460+00	to	462+62.5 lt.	262.5 l.f.
460+00	to	462+62.5 rt.	262.5 l.f.
471+00	to	472+00	100.0 l.f.
478+00	to	486+75	875.0 l.f.
493+25	to	404+00	75.0 l.f.
513+50	to	516+37.5	287.5 l.f.
521+37.5	to	523+00	162.5 l.f.
Total			2525.0 l.f.

II. Nature and Objectives of Experiment

The objective of this experimental project* is to compare the performance of painted steel, galvanized steel, and unpainted aluminum guardrails. The project contains approximately 2,500 lineal feet of each type. All of the rails are the deep-beam-type and are bolted onto painted steel posts. The galvanized steel rail was hot-dipped in accordance with ASTM Designation A 123. These rails will be compared from the standpoint of long-range economics. In addition to this experimental project, other installations of guardrails throughout the State are under surveillance. The steel guardrail posts are also under study from the standpoint of corrosion at the ground line. Fig. 1 (attached) shows the location of the experimental project.

III. Construction Methods

Bids were received in October, 1961. The contract was awarded to the Jones-Hinkle Construction Company. The painted steel and galvanized steel guardrails were installed in November, 1962. The aluminum guardrails were not installed at this time because the test samples failed to meet strength and thickness requirements. A check sample submitted at a later date also failed to meet requirements on strength, thickness, and elongation. A second check sample submitted February 14, 1963, passed all requirements. This sample was tested with devices

Proposed as an experimental feature of construction project, July 31, 1961; approved by Division Engineer, Bureau of Public Roads, August 15, 1961, - reporting to be in accord with P. P. M. 60-2 - approved under HPS-HPR-1(26); Part II, KYHPR-65-42, July 30, 1964.

brought by the company that supplied the guardrails. This was done with the consent of the Department. The aluminum rails were installed in late February, 1963.

All rails were installed in accordance with special provisions which covered material requirements and erection procedures. Copies of these "Special Provisions" may be found in Attachments No. 1 and No. 2.

The following additional features were incorporated in the erection of these rails:

- 1) Special, 5/8" x 2", Bethalume, Coated, Post Bolts with Recessed Hex Nuts (PS 73-226) were installed in one section of each of the three types of rails.
- 2) Special, 5/8" x 1-1/4", Bethalume, Coated, Splice Bolts with Recessed Hex Nuts (PS 73-207) were installed in one section of each of the three types.

The experimental bolts were supplied by the Bethlehem Steel Company. Two of the post bolts and eight of the splice bolts were installed at one spliced section of each of the three types of guardrail. The table below shows the location of each of the experimental bolt installations.

GUARDRAIL TYPE	STATION LOCATION OF EXPERIMENTAL BOLT SECTION	
Non-galvanized	Sta. 626+62.5	NBL
Galvanized	Sta. 627+25	NBL
Aluminum	Sta. 523+00	SBL

The contractors bid price for the three types of guardrails, installed, were

Painted Steel Guardrail	\$2.20 per l.f.
Galvanized Steel Guardrail	2.20 " "
Aluminum Guardrail	3.12 " "
Painted End Sections	3.50 each
Galvanized End Sections	3.50 each
Aluminum End Sections	6.00 each

IV. Performance Survey

A.A. Aluminum Guardrail

The overall condition of the aluminum guardrail is good. None of the rails has been bent or mutilated in anyway - other than small scuffs and scratches which, apparently, were inflicted during construction. All of the rail is still in place and all bolted joints are apparently in good condition. The following is a summary of the field performance notes for each section of rail:

Section 1.

Sta. 432+50-434+25

There are a few scuff marks and scratches made by equipment, etc. There is some very limited tarnishing in these places.

Section 2.

Sta. 449+00-450+50

There is some limited tarnishing in skuff marks, scratches, etc.

Section 3.

Sta. 458+45-459+20

Condition: good.

Section 4.

Sta. 460+00 to 462+62.5 rt.

Condition: good.

Section 5.

Sta. 460+00 to 462+62.5 lt.

Condition: good.

Section 6.

Sta. 471+00 to 472+00

Condition: good.

Section 7.

Sta. 478+00-486+75

There is a very limited amount of tarnish at scraped places.

Section 8.

Sta. 493+25-494+00

Condition: good. The end wing section at Sta. 494+00 has been painted with aluminum paint. There is no apparent reason for this. There is also a painted spot about 2' square at approximately Sta. 493+62.

Section 9.

Sta. 513+50-516+37.5.

Condition: good.

Section 10.

Sta. 521+37.5-523+00.0

Condition: good.

B. Painted Steel Guardrail

The painted steel guardrail was painted with primer paint conforming to the Department's Special Specification No. 14-56 plus finish coat paint conforming to Article 7.23.4-F of the Kentucky Specifications. The overall condition of the guardrail is excellent. There are, however, numerous very small rusted spots where the paint has been chipped. One section of rail (from Sta. 500+00 to 500+50) has been hit by a truck and will have to be replaced. Other than this one section, all the painted steel rail is in place and all bolted joints are apparently in good condition. The following is a summary of the field performance notes for the painted steel rail.

Section 1.

Sta. 500+00-502+50

There is no apparent rusting and no chips in the paint. The rail from Sta. 500+00 to 500+50 has been destroyed by a truck and will have to be replaced.

Section 2.

Sta. 513+50 to 519+12.5

There is some chipping of paint and rusting in the chipped places on the end wing section at Sta. 513+50. There is also a small amount of rusting at Sta. 513+58. This also is due to chips in the paint. There are several very small isolated spots of rust where the paint has been chipped and scrapped. The overall condition of the section is good.

Section 3.

Sta. 519+87.5 to 521+25

There are some isolated spots of rust in practically every section of the guardrail. These are, however, very small and the overall condition if this rail is good.

Section 4.

Sta. 551+25-577+50

There is considerable rusting of the end section at Sta. 551+25. The bulk of the rail is, however, in excellent condition; there is some rusting where the paint has been chipped off.

Section 5.

Sta. 571+25-577+50

Condition is excellent. There are a few very isolated rust spots where the paint has been chipped.

Section 6.

Sta. 597+87.5-603+87.5

Condition is excellent. There are some small, isolated rust spots.

Section 7.

Sta. 613+75-616+00

Condition is excellent. There is practically no rust at all.

Section 8.

Sta. 624+75-626+62.5

Condition is excellent. There are a few isolated rust spots where the paint has been chipped.

C. Galvanized Steel Guardrail

The overall condition of this guardrail is excellent. There is very little rusting. One section (Sta. 651+62.5-652+12.5 NBL) has been damaged by a vehicle. The rail is, however, only very slightly damaged and will not have to be replaced; otherwise, all of the galvanized rail is in place, and all bolted joints are apparently in good condition. The following is a summary of the field performance notes.

Section 1.

Sta. 534+50-539+75

There is no rust except for one very small isolated spot about 2"

square. This apparently was due to the galvanizing material being chipped during construction.

Section 2.

Sta. 552+625-553+62.5

This rail is in extremely good condition. There is no apparent rusting.

Section 3.

Sta. 567+37.5-575+12.5

There is a very small daub of aluminum paint at Sta. 567+37.5 and another at approximately 570+00. These are about 2" x 2". These paint daubs apparently cover scars in the galvanizing material. There is some discoloration of the galvanizing material between Sta. 573+50 and Sta. 573+75. (See Figure 7.) This discoloration has not appreciably damaged the galvanizing material. Other than these sections, the rail is in excellent condition.

Section 4.

Sta. 598+50-604+00

There is a small rust spot at Sta. 598+50 where the galvanizing material has been scraped off. There is a small daub of aluminum paint at Sta. 598+90 and another at Sta. 598+93. These are very small. Some sections of the galvanized rail are dark in color. The material is apparently not damaged but has a darker color than other portions of the rail. There is no rusting. The overall condition of this section of rail is excellent.

Section 5.

Sta. 627+25-632+50NBL

This section is in extremely good condition. There is no rust at all. The galvanizing material is in perfect condition.

Section 6.

Sta. 651+62.5-652+12.5NBL

This section has been hit by a vehicle, and the end section at Sta. 651+62.5 is damaged. All of the posts are leaning. There is however, apparently some rusting of the entire rail. This rail is within 18 in. of the road and may have a greater exposure to salts and splashing from the roadway. The other sections are on the outside edge of a 6-foot shoulder. The overall condition of this rail is good.

Section 7.

Sta. 651+62.5-652+12.5SBL

This rail is beginning to rust very similarly to Section 6. It, too, is about 18 in. from the edge of the pavement. The overall condition of this rail is good.

D. Guardrail Posts

Many of the guardrail posts on all sections have begun to rust (See Fig. 2). This rusting is taking place where the paint has chipped off usually on the portion of the post which is painted with aluminum paint. Most of the posts are exposed below the painted portions - due to settlement, erosion, etc. Some of the posts are exposed as much as 18 in. below the painted portion. There is, however, very little or no corrosion of the posts at the ground level. The overall condition of the steel posts is good.

E. Other Installations under Surveillance

Guardrail on the interstate and turnpike system consist of painted steel and galvanized steel, and the comparative performance of these types of rails is of interest. Service records will be maintained on the following listed projects:

1. Painted Steel Guardrail

- 1) I-65, Ky. Turnpike, Jefferson, Bullitt, and Hardin Counties. Guardrail installed in 1955, at a bid price of \$3.69 per linear foot. That portion of the guardrail in Hardin County has been repainted one time since installation. That portion of the guardrail in Jefferson and Bullitt Counties has been repainted twice since installation.
- 2) I-65, Louisville-Tennessee State Line Road, Hardin and Larue Counties. Portions of guardrail were installed in 1959. The average low unit bid price in 1959 was \$2.90 per linear foot plus \$4.41 for each wing section. Another portion of guardrail was installed in 1962, at an average low unit bid price of \$2.2593 per linear foot plus \$3.8222 for each wing section. None of this rail has been repainted; however, that portion installed in 1959 is scheduled for repainting during the fall of 1964.
- 3) I-64, Frankfort-Louisville Road; Franklin, Shelby and Jefferson Counties. The guardrail was installed in 1962. Contracts were awarded during 1961, at which time the average low unit bid price for guardrail on Interstate was \$2.3307 per linear foot plus \$3.8947 for each wing section. This guardrail has not been repainted.
- 4) I-64, Winchester-Mt. Sterling; Clark and Montgomery Counties; installed in 1961. The average low unit bid for guardrail on Interstate in 1961 was \$2.3307 per linear foot and \$3.8947 for each wing section. None of this guardrail has been repainted.
- 5) I-75, Covington-Lexington, Kenton, Boone, Grant, and Scott Counties. Portions of this guardrail (Williamstown-Covington) were installed during 1961 at an average low unit bid price for Interstate of \$2.3307 per linear foot plus \$3.8947 for each wing section. None of this rail has been repainted; however, the portion between Williamstown and Covington is scheduled for repainting during the fall of 1964 and winter and spring of 1965.
- 6) Eastern Ky. Parkway, Winchester-Campton, Clark, Powell and Wolfe Counties, installed in 1962 at an average low unit bid price of \$2.3154 per linear foot plus \$3.8756 for each wing section. This rail has not been repainted.

2. Galvanized Steel Guardrail

- 1) Western Kentucky Parkway, Hardin, Grayson, Ohio, Muhlenberg, Hopkins, Caldwell, and Lyon Counties, installed during 1962 and 1963. The average low unit bid price for these years on the Western Ky. Parkway was \$2.2184 per linear foot plus \$3.8194 for each wing section. There has been no maintenance cost other than repairs due to vehicle damage.
- 2) EI 75-4(5)90, I-75, Lexington-Tennessee State Line Road, Madison County, installed during 1961 at an average low unit bid price for guardrail on Interstate of \$2.3307 per linear foot plus \$3.8947 for each wing section.
- 3) I-75, Covington-Lexington, Fayette, Scott Counties, installed in 1963 at an average low unit bid price for guardrail on Interstate of \$2.1722 per linear foot plus \$3.7394 for each wing section.
- 4) I-64, Lexington-Winchester, Fayette and Clark Counties; installed in 1962 and 1963 at an average low unit bid price for guardrail on Interstate of \$2.2658 per linear foot plus \$3.7808 for each wing section.
- 5) Eastern Ky. Parkway Extension, Campton-Salyersville, Wolfe, and Magoffin Counties; installed in 1963 at an average low unit bid price of \$2.3154 per linear foot and \$3.8756 for each wing section.

V. Discussion

In general, the overall condition of each of the three types of guardrail on the experimental project is excellent. There have been no maintenance costs on either of the three types to date. It is still too early to draw any definite conclusions; however, it seems that the aluminum rail is performing at least as satisfactorily as the other two types. In many instances, guardrail posts are rusting in the painted portions. Although the posts are exposed below the painted portion, there is no apparent corrosion at the ground line.

Attachments: 2

Figures: 8

SPECIAL PROVISION

FOR

GUARD RAILS

Mercer County
Project F 160 (10)

This Special Provision covers the material requirements and erection procedures for steel and aluminum guard rails to be installed for experimental purposes. Article references are with respect to the Department's 1956 Standard Specifications.

- - - - -

I. DESCRIPTION

This work shall consist of furnishing all necessary materials and erecting deep-beam guard rails of the types listed below, all in full compliance with the requirements hereinafter specified.

1. Non-galvanized, painted steel guard rails.
2. Galvanized, unpainted steel guard rails.
3. Unpainted aluminum guard rails.

The total quantity of guard rail installed on the project shall be divided, as nearly as practicable, in equal footages for each type. The guard rails shall be installed at the locations indicated on the plans or selected by the Engineer.

II. MATERIALS

A. General. All rails and end sections shall conform to Standard Drawing No. 17.03 with respect to dimensions and cross-section, subject to manufacturer's tolerances.

B. Non-Galvanized Steel Guard Rail. The rail elements, end sections, and accessory items shall meet the requirements of Amendment No. 36 to the 1956 Standard Specifications for the 10-gage, 100,000-pound rails.

The rails and end sections shall be furnished with one shop coat of an approved rust inhibitive primer.

Paint for field prime coats shall conform to the Department's Special Specification No. 14-56b for primer coat paint. The paint for the second field prime coat shall be tinted by adding 2 ounces of lampblack to each gallon of paint.

Paint for the finish coats shall be aluminum paint meeting the requirements of Article 7.23.4-F. The paint for the first finish coat shall be tinted by adding not less than 2 ounces of Prussian blue to each gallon of paint made with aluminum powder pigment, and not less than 5 ounces to each gallon of paint made with aluminum paste pigment.

C. Galvanized Steel Guard Rail. The rail elements, end sections, and accessory items shall meet the requirements of Amendment No. 36 to the 1956 Standard Specifications for 10-gage, 100,000-pound rails.

The rail elements and end sections shall be hot-dipped galvanized after fabrication in accordance with the specification of ASTM Designation: A 123. Painting will not be required.

D. Aluminum Guard Rails. The rail elements, end sections, and accessory items shall meet the requirements of the attached Special Provision for "Deep-Beam Type Aluminum Guard Rails" for the 0.156-inch, 100,000-pound rail. Painting will not be required.

E. Posts. The posts may be either timber, steel, or concrete as specified on Standard Drawing No. 17.03. The type of post shall be selected by the Contractor, provided that only one type of post shall be used throughout the project.

F. Sampling and Testing. One rail element and one end section shall be selected at random from each shipment of each type for testing. Paints and other materials shall be sampled in accordance with the applicable requirements of the 1956 Standard Specifications. Testing shall be in accordance with methods adopted as standard by the Department.

III. CONSTRUCTION METHODS

The guard rails shall be erected at the locations indicated on the plans or as selected by the Engineer.

Each continuous section of guard rail shall consist of only one type of rail and corresponding end sections.

Except as otherwise provided herein, the guard rail shall be erected in accordance with the applicable requirements of Article 6.29.0 and Standard Drawing Nos. 17.03 and 17.04.

Prior to the erection of the non-galvanized guard rail, the contact surfaces of the rail overlaps and non-galvanized fittings, and other surfaces inaccessible after erection, shall be given 2 field coats of primer paint. Damaged areas of the shop primer coat shall be cleaned and spot painted with primer. After erection all metal not galvanized shall be given 2 coats of primer paint and 2 coats of aluminum paint.

IV. METHOD OF MEASUREMENT

The guard rail shall be measured in linear feet along the rail from center to center of the end posts for each type of guard rail.

End sections shall be measured as units.

V. BASIS OF PAYMENT

The quantities thus measured, complete and accepted in place, shall be paid for at the contract unit price bid per linear foot for "Non-Galvanized Steel Guard Rail," "Galvanized Steel Guard Rail," and "Aluminum Guard Rail;" and per each for "Non-Galvanized Steel End Sections," "Galvanized Steel End Sections," and "Aluminum End Sections;" which payment shall be full compensation for furnishing and installing all materials, including posts, painting as specified, excavating and backfilling, disposal of surplus material, and all labor, equipment and incidentals necessary to satisfactorily complete the work.

APPROVED

Feb. 23, 1961



D. H. BRAY,
STATE HIGHWAY ENGINEER

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION

FOR

DEEP-BEAM TYPE ALUMINUM GUARD RAIL

This Special Provision covers the material and fabrication requirements for the Deep-Beam Type Aluminum Guard Rail, and shall be applicable only to individual projects when indicated on the plans, proposals, or bidding invitations.

- - - - -

A. General. This item covers the material requirements for rail elements and fastenings fabricated to develop continuous beam strength when installed as indicated on the plans.

The rail elements shall be formed into a beam not less than 12 inches wide and 3 inches deep in accordance with the standard drawings. The beam cross section shall show two corrugations symmetrical about the horizontal axis, with the rounded faces toward traffic and the edges away from traffic. The edges and the center of the rail shall contact each post. Splices shall be bolted and lapped not less than 12½ inches.

Unless otherwise provided, both ends of each installation shall be fitted with terminal sections meeting the requirements shown on the standard drawing.

All guard rail parts furnished under this specification shall be interchangeable with similar parts regardless of the source or manufacture.

B. Rail Element. The rail element shall be of aluminum alloy sheet conforming to ASTM B 209 for alloy clad CG42A-T3 (Alclad 2024-T3).

The rail element shall be designed to meet the strength requirements in the following table. The post connection shall withstand a 5,000 pound side pull in either direction.

STRENGTH REQUIREMENTS

Nominal Thickness (Inches)	Tensile Strength of Joint (Pounds)	Beam Strength*			
		Traffic Face Up		Traffic Face Down	
		Load (Pounds)	Maximum Deflec- tion (Inches)	Load (Pounds)	Maximum Deflec- tion (Inches)
0.125	80,000	1500	3½	1200	3½
		2000	5½	1600	5½
0.156	100,000	2000	4	1600	4
		3000	6	2400	6

*With the rail element supported on 12-foot, 0-inch clear span and the load applied through a 3-inch flat surface at the center of the span. When the joint is tested it shall be at the center of the span.

C. Terminal Section. The terminal sections shall be of aluminum alloy sheet conforming to ASTM B209 for alloy clad CG42A-T42 (Alclad 2024-T42).

D. Fasteners. Aluminum alloy bolts shall be made from rod conforming to ASTM B211, alloy CG42A-T4 (2024-T4). The bolts shall be given an anodic treatment providing a minimum coating of 0.0004 inches of film thickness.

Aluminum alloy nuts shall be made from rod conforming to ASTM B211, alloy GS11A-T6 (6061-T6).

Aluminum alloy washers shall conform to ASTM B 209 for alloy CG42A-T4 (2024-T4).

APPROVED

May 19, 1961


 D. H. BRAY
 STATE HIGHWAY ENGINEER

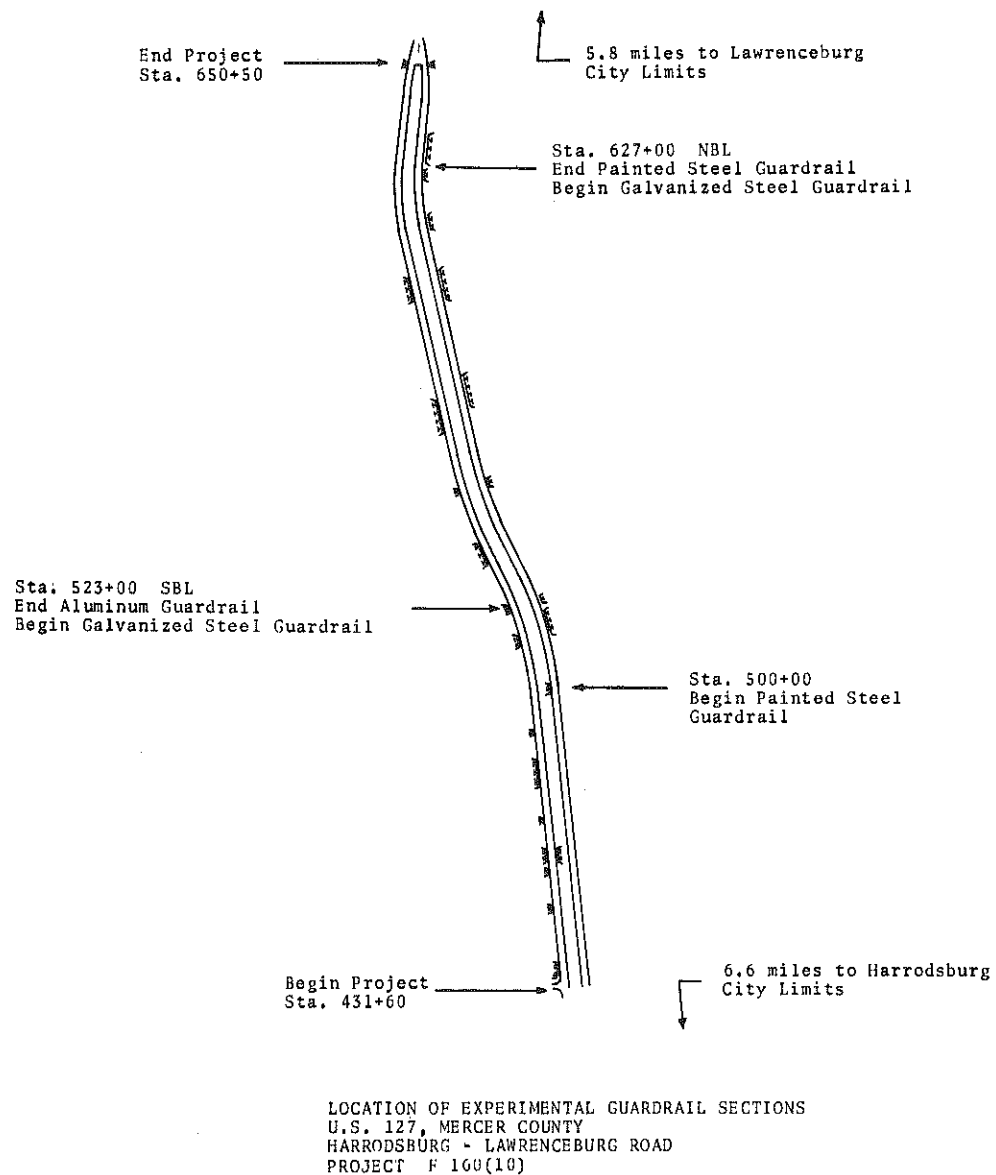


Fig. 1: Map Showing Locations of Construction Project F 160(10) Incorporating Experimental Installation of Aluminum Guardrails.

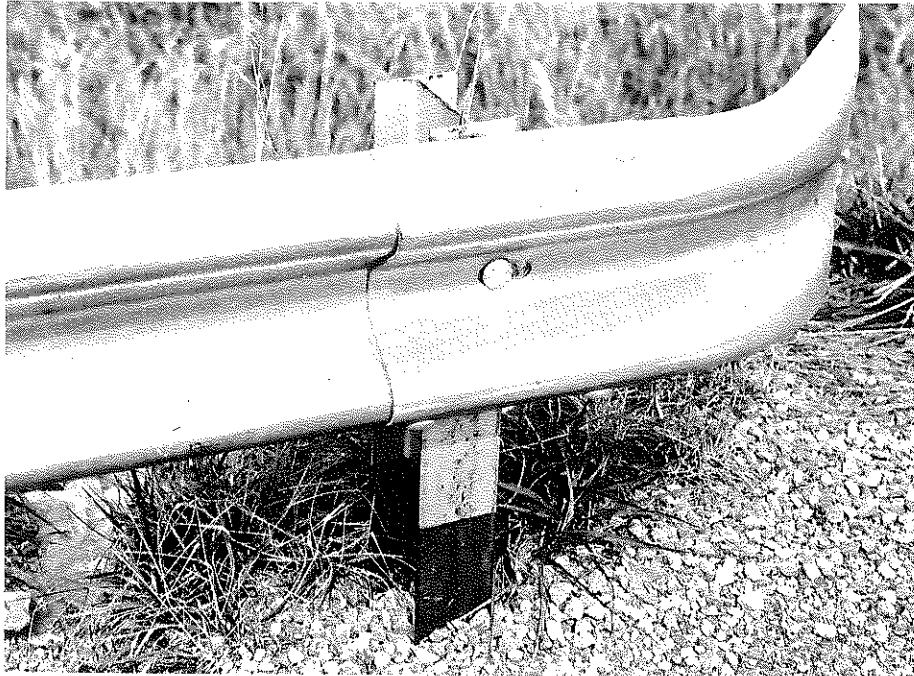


Fig. 2: Rusting of Steel Guardrail Post, Sta. 472+00, Southbound Lane, 8-7-64

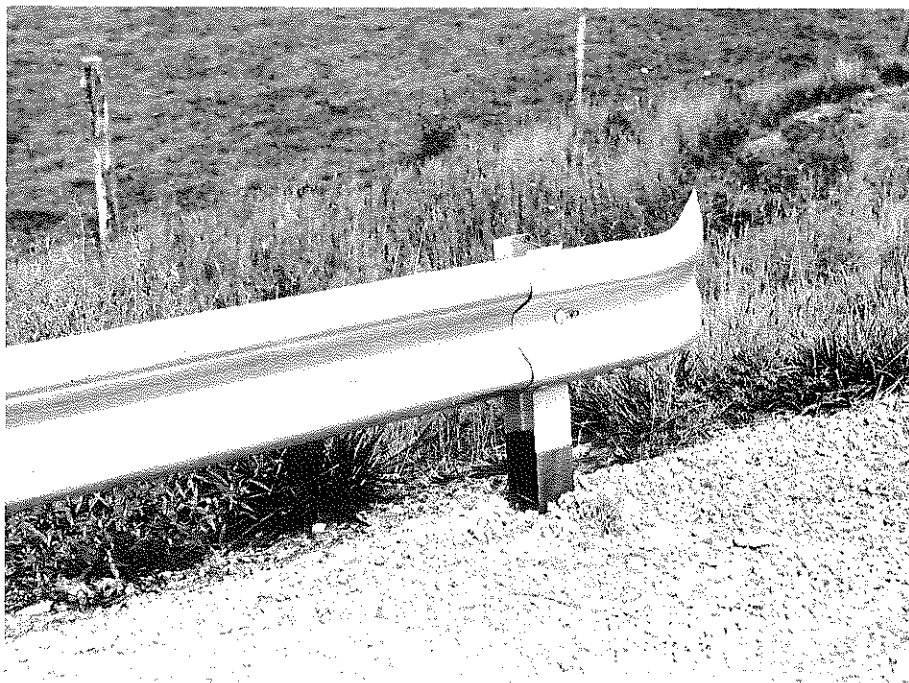


Fig. 3: Painted Aluminum End-Wing, Sta. 493+25, Southbound Lane, 8-7-64

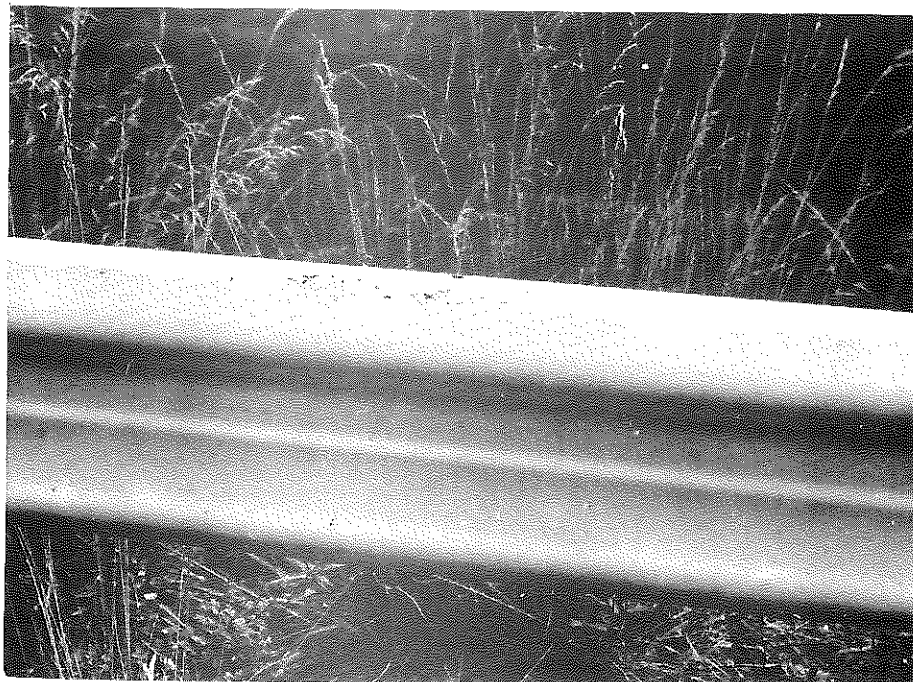


Fig. 6: Rusting of Painted Steel Guardrail, Sta. 576+50
Northbound Lane, 8-7-64



Fig. 7: Discoloration of Galvanized Steel Guardrail,
Sta. 573+50, Southbound Lane, 8-7-64

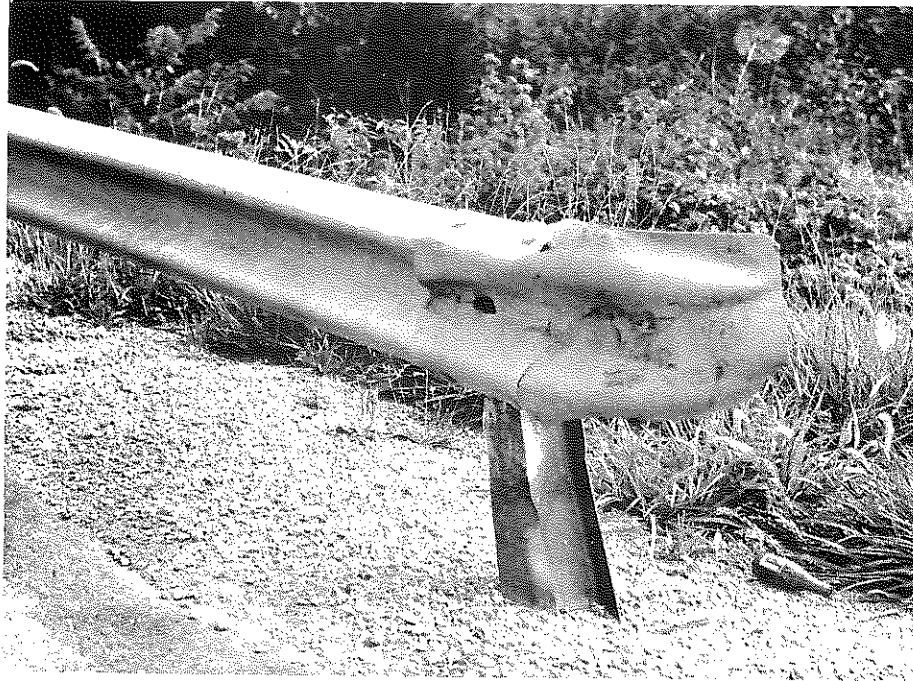


Fig. 8: End-Wing Section of Galvanized Steel Guardrail
Damaged by Vehicle, Sta. 651+25, Northbound
Lane, 8-7-64